

What is claimed is:

- 1 1. A control system for an automotive
2 vehicle having a vehicle body comprising:
 - 3 a first angular rate sensor generating a first
4 angular rate signal corresponding to a first angular
5 motion of the vehicle body;
 - 6 a second angular rate sensor generating a
7 second angular rate signal corresponding to a second
8 angular motion of the vehicle body;
 - 9 a lateral accelerometer generating a lateral
10 acceleration signal corresponding to a lateral
11 acceleration of a center of gravity of the vehicle body;
 - 12 a longitudinal accelerometer generating a
13 longitudinal acceleration signal corresponding to the
14 longitudinal acceleration of the center of gravity of
15 the vehicle body;
 - 16 a wheel speed sensor generating a wheel speed
17 signal corresponding to a wheel speed of the vehicle;
18 and
 - 19 a controller coupled to said first angular
20 rate sensor, said second angular rate sensor, said
21 lateral accelerometer, said longitudinal accelerometer,
22 and said wheel speed sensor, said controller determining
23 a global roll attitude and a global pitch attitude from
24 the first angular rate signal, and the second angular
25 rate signal, lateral acceleration signal and the
26 longitudinal acceleration signal, said controller
27 determining a roll gradient based upon a past raw roll
28 rate and current raw roll rate, the first angular rate
29 signal or the second angular rate signal and the lateral
30 acceleration signal, a pitch gradient based upon a past
31 raw pitch rate and current raw pitch rate the first or

32 second angular rate signal and the longitudinal
33 acceleration signal, determining a relative roll and
34 relative pitch as a function of the roll gradient and
35 the pitch gradient.

1 2. A system as recited in claim 1 wherein
2 said first angular rate sensor is one selected from the
3 group of a yaw rate sensor, a pitch rate sensor and a
4 roll rate sensor and said second angular rate sensor
5 comprises is one selected from the group of a yaw rate
6 sensor, a pitch rate sensor and a roll rate sensor, said
7 second sensor being different than the first sensor.

1 3. A control system for an automotive
2 vehicle having a vehicle body comprising:

3 a roll angular rate sensor generating a roll
4 angular rate signal corresponding to an roll angular
5 motion of the vehicle body;

6 a yaw angular rate sensor generating a yaw
7 motion signal corresponding to a yaw motion of the
8 vehicle body;

9 a lateral accelerometer generating a lateral
10 acceleration signal corresponding to a lateral
11 acceleration of a center of gravity of the vehicle body;

12 a longitudinal accelerometer generating a
13 longitudinal acceleration signal corresponding to the
14 longitudinal acceleration of the center of gravity of
15 the vehicle body;

16 a wheel speed sensor generating a wheel speed
17 signal corresponding to a wheel speed of the vehicle;
18 and

19 a controller coupled to said roll angular rate
20 sensor, said yaw angular rate sensor, said lateral

21 accelerometer, said longitudinal accelerometer, and said
22 wheel speed sensor, said controller determining a global
23 roll attitude and a global pitch attitude from the roll
24 rate, lateral acceleration signal and the longitudinal
25 acceleration signal, determining a pitch rate in
26 response to said first angular rate signal, said second
27 angular rate signal, said lateral acceleration signal,
28 said longitudinal acceleration signal, and said wheel
29 speed signal, said controller determining a roll
30 gradient based upon a past raw roll rate and current raw
31 roll rate, the roll angular rate signal and the lateral
32 acceleration signal; a pitch gradient based upon a past
33 raw pitch rate and current raw pitch rate the calculated
34 pitch angular rate signal and the longitudinal
35 acceleration signal, determining a relative roll and
36 relative pitch as a function of the roll gradient and
37 the pitch gradient.

1 4. A control system as recited in claim 3
2 further comprising a safety system coupled to said
3 controller, said controller generating a control signal
4 to said safety system in response to said the relative
5 roll angle, the relative pitch angle, the global roll
6 and the global pitch angle.

1 5. A control system as recited in claim 4
2 wherein said safety system comprises an active brake
3 control system.

1 6. A control system as recited in claim 4
2 wherein said safety system comprises an active rear
3 steering system.

1 7. A control system as recited in claim 4
2 wherein said safety system comprises an active front
3 steering system.

1 8. A control system as recited in claim 4
2 wherein said safety system comprises an active anti-roll
3 bar system.

1 9. A control system as recited in claim 4
2 wherein said safety system comprises an active
3 suspension system.

1 10. A method of controlling a rollover system
2 for a vehicle body of an automotive vehicle comprising:
3 measuring a roll rate of the vehicle body;
4 measuring a lateral acceleration of the
5 vehicle body;
6 measuring a longitudinal acceleration of the
7 vehicle body;
8 measuring a yaw rate of the vehicle body;
9 determining a calculated pitch rate signal
10 from the yaw rate, the roll rate, the lateral
11 acceleration and the longitudinal acceleration;
12 determining a global roll attitude and a
13 global pitch attitude from the calculated pitch angular
14 rate, the roll rate, lateral acceleration and the
15 longitudinal acceleration;
16 determining a roll gradient based upon a past
17 raw roll rate, the roll rate signal and the lateral
18 acceleration signal;
19 determining a relative roll angle based upon
20 said roll gradient;

21 determining a pitch gradient based upon a past
22 raw pitch rate and calculated pitch rate and the
23 longitudinal acceleration signal;

24 determining a relative pitch angle based upon
25 said pitch gradient; and

26 activating a safety device in response to the
27 relative roll angle, the relative pitch angle, the
28 global roll and global pitch angle.

29 11. A method as recited in claim 10 wherein
30 determining a relative pitch angle comprises determining
31 a relative pitch angle using an Euler approximation.

1 12. A method as recited in claim 10 wherein
2 determining a relative roll angle comprises determining
3 a relative roll angle using an Euler approximation.

1 13. A method as recited in claim 10 wherein
2 said step of activating a safety device comprises one
3 selected from the group consisting of an active brake
4 control system, an active rear steering system, an
5 active front steering system, an active anti-roll bar
6 system, and an active suspension system.

1 14. A method of controlling a safety system
2 for a vehicle body of an automotive vehicle comprising:

3 measuring a roll rate of the vehicle body;

4 measuring a lateral acceleration of the
5 vehicle body;

6 measuring a longitudinal acceleration of the
7 vehicle body;

8 measuring a yaw rate of the vehicle body; and

9 determining relative roll angle, the relative
10 pitch angle, the global roll and global pitch angle in
11 response to the roll rate, the yaw rate, the lateral
12 acceleration and the longitudinal acceleration.

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